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SARDAR PATEL UNIVERSITY
M. Sc. Physics IInd – Semester Examination
Thursday, Date: 27-10-2016   Time: 10:00 a.m. to 1:00 p.m.
Course No: PS02CPHY03
Subject: Electrodynamics and Plasma Physics

Note: Symbols have their usual meaning.   Total Marks: 70

Q.1   Select the best possible answer from the choices given below each questions.   (8)

(1)   Maxwell corrected Amperes law in order to satisfy
(a) Ampere's law
(b) Faraday's Law
(c) The gauge condition
(d) Continuity equation for moving charges

(2)   The electric field component of an electromagnetic wave propagating in free space is given by $E = 30 \cos(10^8 t + \beta x) e_y$ V/m. Find the time it takes to travel a distance of half the wave length.
(a) 10^8 s   (b) 3×10^{10} s
(c) 31.42 ns   (d) 3.33 µs

(3)   Metals are opaque mainly due to
(a) Complete propagation of e m wave through the medium
(b) Propagation delay of the e m wave through the medium
(c) E M waves propagate only through the surface of metals.
(d) Non- propagation of e m waves in the conducting medium

(4)   Wave guides can be considered as a
(a) transmitter   (b) resonator
(c) low pass filter   (d) high pass filter

(5)   The dominant mode of EM transmission through a rectangular waveguide is
(a) TE$_{11}$ (b) TM$_{11}$
(c) TM$_{10}$ (d) TE$_{10}$

(6)   What would be the length of a half wave dipole antenna operating in air at 50 MHz?
(a) 3 m   (b) 6 m
(c) 50 m   (d) 25 m

(7)   It is the radiation emitted by the medium when a charge particle passes through the medium relativistically.
(a) Gamma radiation   (b) Bremsstrahlung radiation
(c) Cerenkov radiation   (d) Synchrotron radiation

(8)   Lawson criterion is related to
(a) Fission reactors   (b) Nonlinear Plasma oscillation
(c) Fusion reactors   (d) Landau damping

Q.2   Answer any seven questions. All questions carry 2 marks each   (7x2=14)

(1)   Derive an expression for the relaxation time for free charges in a conductor.
(2)   Define Poynting vector and give its physical interpretation.
(3)   Find the skin depth of an electromagnetic wave of frequency 1.6 MHz in a conducting medium with conductivity $\sigma = 38$ MS/m. Assume $\mu_m = \mu_0$].
(4)   Define retarded time and find the gradient of retarded time.
(5)   Define *cutoff* frequency and *dominant mode* in the case of a rectangular wave guide.
(6)   What are TE,TM and TEM waves?
(7)   Draw the radiation pattern of a radiating dipole antenna.
(8)   What is Lawson criterion? Explain.
(9)   Derive the Boltzmann equation corresponds to plasma and state at what condition it reduces to Vlasov equation.

Q.3(a) Derive an expression for Maxwell's stress tensor.   (6)
   (b) Discuss the reflection and transmission from the interface of two dielectric media of a plane electromagnetic wave at normal incidents.   (6)

OR

   (b) Discuss reflection and transmission of parallel polarized plane electromagnetic wave at oblique incidence. Obtain expressions for reflection and transmission coefficients.   (6)

Q.4(a) Derive the relevant equations for the propagation of a TE mode in a rectangular wave guide. Obtain expression for its cut off frequency.   (6)
   (b) A TM mode operating at 3GHz is propagated in an air filled wave guide. If

$$E_s = \sin(\frac{2\pi x}{a})\sin(\frac{\pi y}{b})\cos(\omega t - 10z) \text{ V/m}$$

   Find the cut off frequency for its dominant mode and components of the E and H field strengths. (6)

OR

   (b) Derive an expression for the radiation resistance of a Hertzian dipole antenna.   (6)

Q.5(a) What are synchrotron, Bremsstrahlung and Cerenkov radiations? How are they produced? Compare their radiation patterns.   (6)

   (b) Using kinetic theory of plasma derive dispersion relation for plasma oscillation and Explain Landau damping?   (6)

OR

   (b) Derive Larmor formula in the case of radiation due to a moving point charge.   (6)

Q.6(a) Discuss the formation of sheaths in plasma. Derive the sheath equation.   (6)
   (b) Write a short note on the Ponderomotive force.   (6)

OR

   (b) Write short note on Bohm Sheath criterion.   (6)

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